

MEASURING THE VALUE OF TRANSIT ACCESS FOR
DALLAS COUNTY: A HEDONIC APPROACH

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Advocates of urban light rail transit argue that positive developments around station area(s) should offset the costs of implementing a transit system by creating more livable communities and enhance surrounding residential property values. In some cases, decreased urban landscape aesthetics have been reported. The purpose of this study is to contribute to this debate via an analysis of the impact of the Dallas Area Rapid Transit system on residential property values in Dallas County. By examining the impact of distance on property values of two features of the DART system: the transit station and the rail line, and by holding a series of structural variables constant, a net change in value can be calculated using a multi-regression model.

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CHAPTER 1

INTRODUCTION

Urban Transportation Dynamics

Transportation and the location of accompanying infrastructure have direct impacts upon residential location (Alonso, 1964; Muth, 1969). The highway system and its perceived degree of accessibility have provided people with residential opportunities far from urban centers that are more affordable. The desire for increased living space has brought with it a dependency on the automobile. With increasing populations forced to commute in single occupied vehicles, traffic congestion threatens the functionality of many US metropolitan areas (Savitch, 2002).

Accessibility in urban areas diminishes due to the overwhelming presence of automobile travel. Congested highways create an increased friction of distance to employment centers. Alternative modes of transportation deserve attention, especially in metropolitan areas prone to urban sprawl. The re-implementation of transit systems throughout U.S. cities reflects the increased demand brought on by the flaws of auto dependency. Potential for rail transit to attract passengers exists as the dysfunctional element of highway congestion affects the lives of commuters. Transit rail station areas begin to attract

investment due to the shifting perspectives of urban accessibility. Light rail transit (LRT), a form of urban rail that utilizes new or existing rights of way through metropolitan areas, has an advantage in its ability to integrate into existing urban settings. It is capable of running at multiple levels, such as at the street or underground. Urban residents may choose LRT as a viable transportation option other than the automobile. A key characteristic of LRT is its frequent service of smaller vehicles when compared to commuter rail systems.

The main problem facing LRT systems is the cost of implementation and operation. The fiscal sustainability of LRT systems is often difficult to achieve leaving the financial burden upon the taxpayer. Clower and Weinstein (2002) observed that transit systems in mature cities such as Washington, D.C. and Hong Kong were able to recoup operating expenses from the rents paid in adjacent properties owned by the transit agency. Newer rail systems, especially in the southwestern United States, often do not own large amounts of property surrounding their transit stations. For this reason, proponents of rail transit have the burden of finding secondary sources of revenue caused by transit infrastructure such as elevated property values surrounding transit stations. The benefit is not in direct rents paid but increased property taxes paid to the city.

With the challenge of demonstrating the fiscal sustainability of LRT, this research poses the possibility of discovering external revenue sources for transit. The advantage of living close to a transit station and its associated access may be a perceived amenity. Access to a well-developed transit system permits

property owners to appreciate its implicit value (Litman, 2002). A station area resident no longer needs to rely upon an automobile for daily necessities.

Research Objective

In an attempt to examine the success of light rail development in Dallas County, Texas, this thesis will investigate, identify, and evaluate property values in proximity to transit stations and rail lines of the Dallas Area Rapid Transit (DART) rail system. The underlying hypothesis is that light rail operational costs can be mediated by property value appreciation rates in proximity to transit stations while also considering the potential negative impact of the rail line.

Research Focus

The research aims to evaluate residential property values and their relationship with LRT in Dallas County. The focus of this analysis determines the relationship of proximity for two features: the transit station (amenity) and the rail line (nuisance). Specific questions include the following:

- Do property values respond positively to the transit station and negatively to the rail line?
- How does proximity to DART's infrastructure influence property values in a regional context?
- Do property values in certain urban environments (housing type and income) react to the transit station differently?

CHAPTER II

LITERATURE REVIEW

Potential for Transit-Oriented Development

Before the emergence of auto-oriented development, cities were more concentrated in population using rail as a release mechanism for managing housing demand and over-populated urban centers. The availability of livable space became dependent upon the expansion of rail systems (Adams, 1970). Without the automobile, a symbiotic relationship formed between urban land-use and spatial expansion. Due to the limits of transportation, residential, industrial, and commercial land use integrated in a denser form. Developers provided housing close to labor-intensive industry. It demonstrated the efficient tendencies of development without the influence of the automobile. An opportunity exists to create a functioning urban city if policy makers draw from transit's history. A balance between light rail and the automobile leads to increased access in city centers (Litman, 2004).

In an effort to manage sprawl and create livable environments, researchers are embracing the opportunities of public transit, particularly light rail. In the 21st century, demographers are seeing people move to city centers with mostly immigrants and young professionals leading the way (Belzer, 2002). Successful LRT not only provides efficient transport, but also the opportunity to

establish livable communities (Cervero & Duncan, 2001). When considering the term 'livability' in an urban context it is necessary to properly define characteristics of a livable city. Vuchic (1999) outlined criteria for a livable city by using two sets of objectives:

- Human-oriented and environmentally friendly; (convenient, safe, and pleasant)
- Economically viable and efficient.

Air and noise pollution, car accidents, and traffic congestion all detract from livable urban environments. Despite all these negative consequences of the automobile, it still remains the preferred choice of urban transport.

Unpleasant conditions plague many auto-oriented communities and detract from the quality of public services. Urban amenities lose their value when set among the undesirable elements of automobile use.

Urban planners view transit-oriented development (TOD) as a key element of 'Smart Growth' strategies (Belzer, 2002). TOD refers to a type of land use design that takes advantage of the transit station and the human traffic it provides. Cafes, movie theatres, and other outlets for social interaction facilitate a cohesive existence within a station's environs. Not only entertainment, but also basic needs such as dry cleaning and grocery shopping help support effective TOD. When integrated with TOD, high-density residential development attracts retail and in turn creates economic growth (Allen, 2002). If left to the automobile, big box retail influences consumer spending while not contributing to social exchanges in urban settings. This is why, in order to implement retail on a local

scale, transport networks need to be designed to focus upon pedestrian oriented design and deter suburban development. Impediments to pedestrian traffic, such as high-speed arterials, and desolate alleyways do not support TOD and hence detracts from local retail. In its truest form, TOD serves as a catalyst towards socio-economic development.

Emphasizing higher density residential space comes with economic and social benefits if the space is designed with both in mind. Developers cannot simply place high-density units next to rail stations and realize the advantages of TOD. Integrating units with the surrounding environment is important to consider in making them attractive in the marketplace and promoting livable space.

Residents with accessibility to LRT have reduced transportation costs as an added advantage in their location. People within walking distance of a transit station are potentially capable of living without an automobile and thus, conserving their income if daily items are available for consumers. Transit infrastructure and its associated development have the opportunity to transform a city's morphology (Caffrey, 2006). Activity generated by residents establishes a client base necessary to attract public and private investors to these station areas. This mutually beneficial arrangement translates into larger domestic investments and increased land value for its residents.

The Dallas Metroplex and Accessibility

The Dallas-Fort Worth Metroplex is characterized by sprawling suburbs and overburdened freeways, both contribute to traffic congestion and elevated

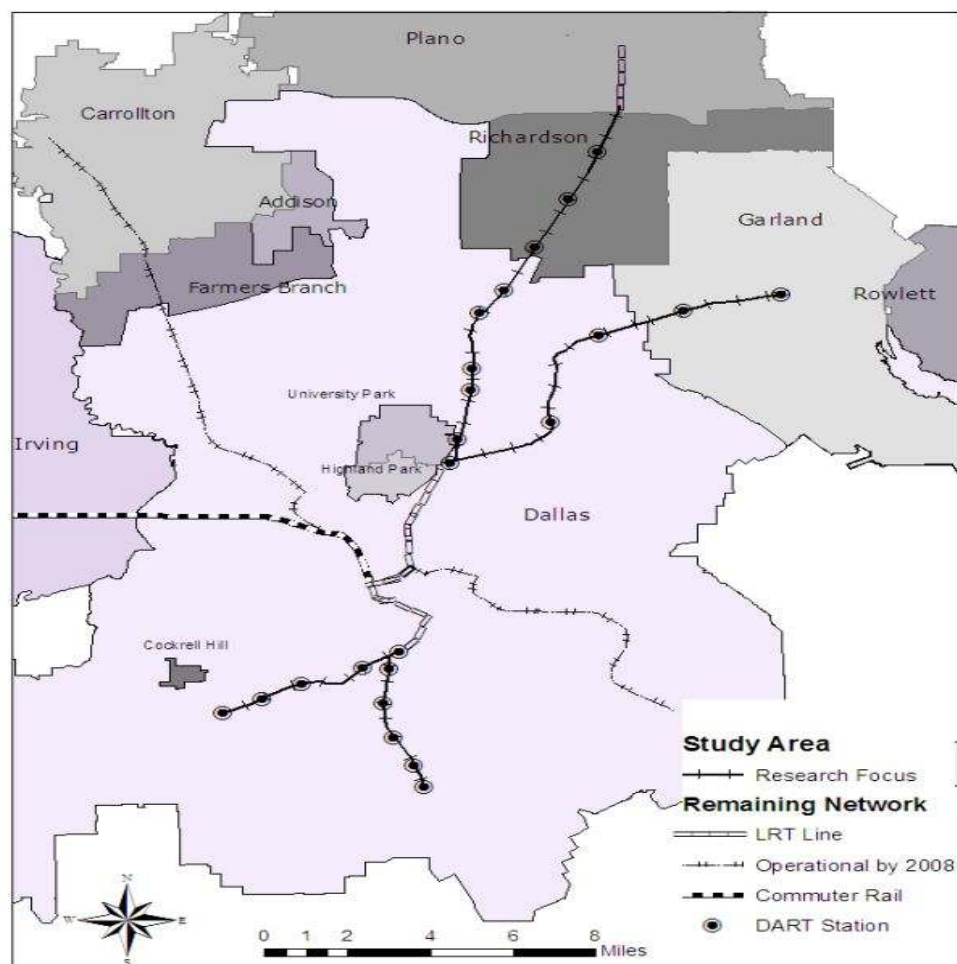
ozone levels. Between 1990 and 2001, the Dallas-Fort Worth metropolitan areas experienced the highest population growth rates in the country at 34 percent (Weinstein & Clower, 2004). As existing highways and available land perpetuate sprawl, accessibility in the Metroplex suffers with increased time spent in traffic. The price of traffic congestion for the Dallas-Fort Worth region was estimated at \$5.3 billion for the year of 2000 due to the loss of productivity and increased transportation costs (NCTCOG, 2006). For this reason, city officials in the Dallas area and the Texas Department of Transportation strive to maintain accessible routes to re-invigorate their urban core.

A key to a vibrant central city economy is the effectiveness of a reliable transport infrastructure whether it is a rail or highway system. Dallas, like many other cities, competes with its suburbs or 'edge cities' for attracting jobs and residents. Dallas began to receive less retail revenue than their 'edge cities' after having a stagnant retail base from 1980 to 1995 (Briggs, 1997). The development of first tier cities being those located closest to the CBD of Dallas, such as Garland, Irving, Richardson, and Farmers Branch happened in the 1950's. Since then further sprawl has occurred creating second tier cities such as Carrollton and Plano and extending further to the third tier cities of Lewisville and Flower Mound.

It is important to consider the revenue that the 'edge city' draws away from Dallas and actions that the city must implement to remain competitive. In an effort to provide its citizens with alternative accessibility to the Dallas Central

Business District (CBD), the Dallas Area Rapid Transit (DART) authority completed the Red and Blue lines of its light rail system in the period from 1996 to 2001. In 2006, ridership levels reached 62,400 people each day making it the seventh most-ridden rail system in the country (American Public Transportation Association).

Figure 1. Study Area and the Future DART Expansion



With sprawling suburbs taking precedent over denser urban living, a reliance on the automobile escalates. Dallas, being one of the more recent cities in the United States utilizing a light rail line, lacks the residential development surrounding their station areas like the cities of the northeast. The highway system influenced the location of residential development rather than the rail line. For this reason, Dallas and its potential adaptability to TOD have a disadvantage due to its rapid growth during the emergence of the automobile era. Some researchers consider that the impact of an added infrastructure such as DART will have little to no effect on urban form due to established highway systems and its convenient accessibility (Cox & O'toole, 2004).

Approaching the ten-year mark, substantial investment, both commercial and residential is occurring in certain areas of the DART rail network. A study that focused on investment within a ¼ mile of transit stations conducted by Weinstein and Clower (2005) performed an analysis that concluded, "the total value of new investment completed, underway, or planned near DART stations since 1999 is more than \$3.3 billion" (Weinstein & Clower, 2005, 2).

The decision to choose LRT may gain popularity due to the shifting perspectives of auto travel. The reaction residents have towards transit stations depends partly on the service it provides. DART is in the process of extending its system to other parts of the Metroplex, thus increasing its network potential. In the near future, residents of Dallas County will be provided with affordable and reliable access throughout the entire Dallas metropolitan area.

Solvency and Costs

Fiscal sustainability of DART rail depends on direct revenue generated from ridership and consumer sales tax. The City of Dallas began investing in its LRT system in 1990. The DART system subsidizes most of its operating expense through a 1% sales tax supplied by its member cities (Clower & Weinstein, 2002). LRT systems throughout the U.S. are heavily dependent on government subsidies. Table 1 compares the fiscal situation of the DART system to select U.S. cities with LRT. DART has the unenviable situation of having the second highest operating cost along with the second lowest fare revenue. The city of Portland, Oregon, commonly thought for its 'Smart Growth' strategies, is listed with the largest operating subsidy (Litman, 2004). Philadelphia and Sacramento both generate higher revenues with lower operating costs and Philadelphia has over 3 million vehicle miles traveled. With such an economic liability, especially for the DART system, city residents need to be continually convinced its utility.

Table 1. Light Rail Statistics for Selected U.S. Cities, 2002

City	Vehicle Miles Travelled (000 miles)	Operating Cost (000 \$)	Fare Revenue (000 \$)	Operating Subsidy (000 \$)
Portland, Ore.	5,664	56,258	17,257	39,001
Dallas	3,971	44,918	5,974	38,944
Baltimore	2,634	32,027	6,205	25,822
St. Louis	5,156	34,025	9,605	24,420
Philadelphia	3,027	31,425	14,331	17,094
Buffalo, NY	838	14,735	3,155	11,580
Sacramento	2,128	26,201	15,043	11,158

Garret, 2004

Recognizing the high cost to the taxpayer, it merits further research to explain possible external economic benefits of LRT such as increased property values adjacent to transit stations. The transit station area may serve as a convenient form of access and attract private investment which may develop the area as a livable place without the need of an automobile. With an increased demand for this type of lifestyle, property values may become higher closer to transit stations. Benefits from increased property values in station areas can assist in supporting the provision of transit subsidies. However, depending upon the presence and quality of the amenities provided by transit station areas, they may evolve into featureless commuter nodes populated with high value office buildings and parking lots that have minimal benefit for nearby residents. In an absence of pedestrian-oriented livable communities, the true utilization of transit

may be left unfulfilled. By assessing whether a station has a positive or negative economic impact from property values, planners can better guide further TOD that benefits the resident and increase the utility of LRT (Garret, 2004).

Property Values and Light Rail Transit Stations

The research conducted on property values and transit stations involve a variety of approaches. Not only light rail transit, but also other types of systems (i.e. commuter and trolley) contribute to the collection of studies. Furthermore, the degree that property values react to transit stations generally involves three common factors. Transportation planners acknowledge many factors as to how much the transit system improves upon access. Parsons Brinckerhoff, a prominent engineering firm, focuses upon three main indicators in assessing a transit station area. The first indicator is the potential for the transit system to improve upon access such as the extent of the network and the frequency of service. Second indicator is the attractiveness of the urban setting in the station area. Lastly, how does the real estate market in the station area compare to the market in the metropolitan area (Parsons Brinckerhoff, 1999).

Property values react to many environmental factors in both positive and negative ways depending upon the variable of distance. For example, proximity to parks and hazardous waste sites both hold positive and negative influences upon home values respectively. Transit systems not only have positive qualities but also negative ones. The transit station provides convenient access and the rail line is associated with negative effects such as noise and vibration.

Proponents of transit are eager to recognize the tangible benefits of elevated property values near transit stations. A positive externality of increased land value near transit is a benefit used by planners to support implementation strategies. Appreciated land value serves as an incentive for residents and developers to invest in neighborhoods adjacent to transit stations.

McMillen & McDonald (2004) determined that higher appreciation rates of transit area land values were enough to pay for half the cost of Chicago's Midway line during the period of 1983-1999. Cervero & Duncan (2001) noted elevated land values created other positive outcomes. This research dealt with commercial development, which has greater capitalization potential than residential land use. He observed that in California, there were numerous lawsuits waged against transit agencies by business owners who claim the nuisance of rail damaged their economic potential. If experts were capable of providing testimony of transit's positive influence, the transit agency would be able to release itself from the burden of most of these suits. Once confident of this relationship, transit agencies become eager to purchase vacant parcels or engage in joint development with private developers. With a finite amount of parcels surrounding transit stations, property values react to supply and demand. Past studies have indicated that it is desirable to perform property value analysis after the rail system has had time to integrate into the market place (Nelson, 1992). Since the inception of DART, properties in station areas have had time to reach equilibrium in the marketplace. If the transit station serves as an amenity

to nearby residents, there should be an adequate amount of time that has passed for a premium to be reflected in the residential location. With DART being more than ten years old, housing markets have had time to respond to the transit infrastructure.

The distance that property values exhibit economic impact is limited in range. The boundaries of this range usually extend to the limits a pedestrian can comfortably arrive at a destination. Any location beyond the limits of a pedestrian scale loses the influence whether positive or negative (Victoria Transport Policy Institute). Consequently, the majority of research involving TOD encompasses an area around a transit station within a $\frac{1}{4}$ to $\frac{1}{2}$ mile (Allen & Benfield, 2003).

In contrast to the economic benefit of a transit station, the rail line may serve as a nuisance with its associated air pollution and noise (Nelson, 1992). Strand and Vagnes (2001) performed a hedonic analysis on the relationship between light rail lines and property values. A hedonic model is capable of measuring the quality of a product by incorporating multiple attributes in a multiple regression equation. They determined a decline in property values due to proximity. Using a log-linear model, the results indicated a 10% increase in price as one doubled their distance from the rail line (Strand and Vagnes, 2001). They introduced three possible nuisance effects created by the rail line. Noise and vibrations are obvious negative effects, which vary depending upon the proximity to the source. Second is the aesthetic quality of a railroad track and its potential for a barren landscape. People immediately adjacent to a track may

suffer lower property values than nearby properties not in visible range of the track. Finally, the track may serve as a potential barrier to pedestrian or auto traffic.

Landis (1994) conducted a real estate impact study of five LRT systems in California. One of the systems included in his research was the Bay Area Rapid Transit (BART) system of San Francisco. Based on 1990 sales transaction data for the Alameda and Contra Costa counties, a hedonic price model estimated the effects of distance on transit stations and highway interchanges for single-family homes. Independent variables included in the model accounted for housing characteristics, neighborhood quality, and transportation access. The model developed location variables to ascertain the influence that accessibility has on property values. Landis (1994) incorporated variables based upon adjacency and measured distance to transit stations and highway interchanges. For the 'adjacency' variable, the study assigned dummy variables to properties on whether they were within 300 meters of a station or highway interchange.

Variables for housing characteristics included lot size, living space, number of bathrooms and bedrooms, and age of structure. In order to capture neighborhood quality, percentages of homeowners and their income accounted for the remaining variables.

The 'adjacent' variable proved to be statistically insignificant. Being adjacent (within a 300 ft buffer) to transit stations and highway interchanges had no significant effect on property values. Yet, measured distances from the

station and highway interchange produced significant results. Highway interchanges decreased property values while the transit station held a premium on home values. In Alameda County, for every meter a home was closer to the nearest BART station, its price increased by \$2.29, all else being equal. Contra Costa County had a lower rate of appreciation at \$1.96 per meter (Landis et al. 1994).

Landis (1994) found the opposite situation when applying the model on measured distances to highway interchanges. The feature depressed home values for both counties. Residents do not value living closer to a highway interchanges. There is little advantage in commuting time living closer to a highway interchange. In Alameda County, homes declined \$2.80 in value for every meter closer to a highway interchange.

A study conducted by Cervero and Duncan (2002) for San Diego County showed that multi-family housing attained higher premiums than single family housing when accounting for properties within one mile of a transit station. They performed separate analyses throughout San Diego County and found incidences of land-value premiums for condominiums and single-family housing. For the corridor along the coastline, property values had higher premiums for being within a half mile of a transit station. Properties within a half mile of transit stations for condominiums had a premium of 46 percent when compared to properties outside a half-mile radius. Single-family housing only had a premium of 17 percent for the same corridor (Cervero & Duncan, 2002).

Weinstein and Clower (2003) have extensively studied the impact on property values for DART. Their method separated the housing into separate housing types including multi-family residential, single-family residential, office, retail, and industrial. The technique utilized thoughtfully chosen control groups for comparison. The analysis aimed to compare the valuations of taxable property values within a quarter mile from a transit station between 1997 and 2001. For multi-family property, median values increased 42 percent for the transit station area and 34.8 percent for the control group. Single-family dwellings responded more strongly to the presence of a transit station with an increase of 38.2 percent and 20 percent respectively.

Researchers often incorporate neighborhood incomes into their property value analysis and transit access. Gatzlaff and Smith (1993) found that residents in higher income neighborhoods experienced elevated property values, while lower income residents experienced no impact from living near transit access. Bowes and Ihlanfeldt (2001), and Nelson (1992) found that high-income neighborhoods were negatively affected by MARTA stations in Atlanta while lower income neighborhoods gained value from the presence of a transit station.

Econometric Analysis

Researchers dealing with measuring property value responses utilize econometrics in order to provide empirical content to economic theory. Regression analysis is capable of controlling for multiple factors while isolating

the influence of a single variable. The model can be designed to compare time (time-series) or at a single instant (cross-sectional) (Wooldridge, 2003).

There is a vast amount of literature on the utilization of the hedonic model. Developed by Rosen (1974), the model's utility is for determining implicit values for goods and services assuming pure competition. In this study, it is capable of determining how a particular feature, such as proximity to rail stations, influence the valuation of properties. Proximity to a myriad of factors such as a 'good view' or 'polluted air' help policy makers place a value on a nuisance or an amenity. With the increased sophistication of Geographic Information Systems (GIS), econometric analysis becomes possible by developing appropriate regression models.

Location is a key factor when purchasing a home. It is possible to determine the implicit value consumers are willing to spend on locating near transport infrastructure depending on the neighborhood setting. A frustrating issue facing urban geographers assessing urban form is local context. Local features are difficult to control for when assessing an entire metropolis or across a national scale. Sirmans (2003) conducted a sample survey of journal articles accounting for the multiple features involved in property value responses in the journal of Urban Geography. Table 2 provides common variables that were included in the papers using the hedonic model. This table presents variables that create negative and positive effects on property values.

Table 2. Environmental Neighborhood and Location Factors

Variable	# of appearances	times positive	times negative	not significant
Location	9	7	2	0
Golf Course	9	9	0	0
On Alley Way	3	0	1	2
On 2-way street	1	1	0	0
Busy street	2	0	0	2
Interstate	3	0	3	0
Arterial Road	1	0	0	1
Traffic Area	3	0	2	1
In city	1	1	0	0
Close	3	0	0	3
Distance	15	5	5	5
Distance ²	2	1	1	0
Commute time	1	0	1	0
CBD time	4	2	2	0
Waste	4	2	1	1
School	1	1	0	0
Landfill	1	1	0	0
Metro Area	1	0	1	0

Sirmans, 2003

Distance, as a variable, is convenient and common to include in hedonic models. The transit station does not appear but auto forms of transportation appear. The difficulty to isolate variables that have significant relationships in the research sample depends upon understanding local influences. The extent of the influence of local externalities is the challenge in designing a hedonic model. For instance, housing characteristics and their value vary throughout regions of the United States. People of the Southwest do not value car garages as much as the Northeast region. An older population does not value a good school district as much as families with school age children. Therefore, context of the study area is important to consider when interpreting the response of independent variables (Sirmans, 2003). Do property values react positively to transit station areas in a society of auto dependency such as Dallas?

CHAPTER III

METHODOLOGY AND RESEARCH AREA

Procedure

The study area encompasses 23 station areas along with 18,164 residential properties in Dallas County. The research includes all properties located within 3000 feet from their respective transit station. The Dallas Central Appraisal District (DCAD) provided cross-sectional data for assessed residential property values for 2005 that included their structural characteristics. The elements extrapolated from the data were the parcel's address, age of structure (yrs), living area (sq ft), number of bathrooms and half-bathrooms, and the condition, desirability and utility (CDU) rating. A CDU rating is a qualitative description based upon an assessor's on-site review. The CDU rankings are based upon detailed descriptions outlined in the appendix (Texas Comptroller of Public Accounts).

Certain stations in the Central Business District (CBD) and Collin County were not included in the study for the following reasons;

- Stations in the CBD proved difficult to analyze due to exogenous factors effecting assessed property value other than the presence of transit infrastructure.
- Station areas in Collin County incorporate separate appraisal districts resulting in different accounting procedures and assessing techniques.

Listed are the required files for the analysis;

1. Tiger street files for Dallas County
2. DART rail lines and stations
3. 2000 Census tract shapefiles

Source: North Central Texas Council of Governments (NCTCOG)

4. 2005 DCAD Appraisals (Dallas County Central Appraisal District)
5. 2000 US Census Summary File 3 (2000 US Census).

The analysis utilized three software packages. Microsoft Access helped select properties within the large database and minimize the DCAD file to only the select residential units along with their structural characteristics. ArcGis 9.0 geocoded the addresses and generated a point shapefile containing their structural characteristics. Once parcels became located on the street network, Euclidean distances were measured from the nearest rail line and transit station.

The SF3 file provided per capita income (PCI) by census tract for each station area. Each data point acquired the corresponding PCI value of its census tract, creating an average PCI value for each station area. SPSS statistical software created descriptive tables, charts, and performed multiple regression output. A compilation of multiple regression models helped develop comparisons of gradients in a regional context based upon housing type and income.

Model Specifications

The model takes the general form of Equation 1 so that P_i represents the estimated price of parcel i . Vector S is the structural variables associated with the assessed value of the property. They include the living area (sq ft), condition, desirability and utility (CDU) rating, number of bathrooms and half-bathrooms, and age of the structure (yrs). Vector D includes two variables associated with Euclidean distance to transit stations and rail lines.

Equation 1: General Form

$$P_i = f(S, D)$$

The influence that each characteristic has on property values become quantified by developing a multiple regression equation. Equation 2 represents a linear functional form for estimating the value of property characteristics by following the change in property values.

Equation 2: Linear Functional Form

$$P_i = \text{constant} + \beta_1(\text{living area}) + \beta_2(\text{CDU}) + \beta_3(\text{\#of Bathrooms}) + \beta_4(\text{age}) + \beta_5(\text{distance to rail}) + \beta_6(\text{distance to station})$$

The equation consists of the primary structural characteristics along with measured distances to the nearest transit station and rail line. The computed coefficients (β) represent the marginal increase in property values that results from a one-unit increase in that particular property characteristic, holding all else constant. To incorporate a non-market good such as proximity to a feature allows a price to be associated with that variable. With a one-unit increase in

distance, there is a corresponding reaction to the dependent variable as interpreted through the coefficient value.

With distance to the station and rail being the focus, coefficients β_5 and β_6 are key indicators throughout the study and are referred to as 'Distance' variables. In linear form, when the measured distance increases by one-unit, the estimated property value responds by a factor of the computed beta. For example, if the distance coefficient produced a negative value of $-\beta_{5,6}$ then the property value in the region decreases \$ β as distance increases one unit from the measured feature. This relationship symbolizes a positive economic impact on property value due to the feature.

Equation 3 has the added convenience of providing elasticity to the dependent and independent variables. For this equation, when taking the natural log of each component, it provides flexibility when interpreting the relationship as well as normalizing the distribution of the dependent variable.

Equation 3: Logarithmic Functional Form

$$\ln(P_i) = \text{constant} + \beta_1 \ln(\text{living area}) + \beta_2 \ln(\text{CDU}) + \beta_3 \ln(\text{\#of Bathrooms}) + \beta_4 \ln(\text{age}) + \beta_5 \ln(\text{distance to rail}) + \beta_6 \ln(\text{distance to station})$$

The coefficient of the independent variables represented as β interprets as a percentage response. A one percent change in proximity leads to an estimated $\beta\%$ change in the independent variable being the predicted property value. Therefore, β is the elasticity of property value with respect to a change in

distance. For this study, the limit of proximity extends to 3000 feet making a one percent change in distance equal to 30 feet.

For every 1% increase of 'Distance-Station' or 'Distance-Rail', there is a corresponding β_5 and β_6 percentage change in property value (P_i). When interpreting the results of Equation 3, a negative sign of β_5 or β_6 (Distance variables) symbolizes a positive economic impact from the respective feature. A negative economic impact is defined as the 'Distance' coefficients β_6 or β_7 achieving a positive sign. If the coefficient had a positive sign, the literal interpretation would be that property values increases in price, as distance from the station becomes greater.

Research Area

Regional Corridors

The red and blue lines of DART extend into the north and south regions of Dallas County. Subsequent partitioning of the lines into north-south segments created four corridors (See Figure 4). When mentioning a 'corridor', it is defined as the region of the LRT system including the transit station and rail line. The rail line refers to the actual physical line. Each corridor has different compositions of housing by size, value, type, and income.

The north central corridor (NC-Red) has the majority of stations with nine and has the second most housing units with 5,487. The northeast corridor (NE-Blue) has both the least amount of stations and housing. With four stations, NE-Blue has only 1,558 residences. The southwest corridor (SW-Red) has slightly

less housing than NC-Red with 5,214 units and only 5 stations. It also has a station area (Hampton) with the highest residential density for the entire study area at 1,785 units. The Hampton and Tyler/Vernon station areas each had higher counts than the entire NE-Blue corridor. Lastly, the south central corridor (SC-Blue) has the most housing with 5,905 units with only 5 station areas.

Table 3 lists the stations for each corridor by their distance to the CBD of Dallas. For example, the column for NC-Red begins with Mockingbird, the closest to the urban core, and finishes with Galatyn Park located at the periphery (See Figure 3 & 4). The column labeled 'Percent' reflects the percentage of housing in each station area within their respective corridor.

The majority of the housing for NC-Red is located closer to the Dallas CBD in the station areas Mockingbird (14.6%), Lovers Lane (31.5%), and Park Lane (16.1%). When combined, these three station areas contain 62% of housing for NC-Red. NC-Blue also has its majority of housing closer to the CBD of Dallas in the station areas of White Rock (40.6%) and LBJ/Skillman (25.8%).

Table 3. Statistics of Residential Populations for the Station Areas

Corridor	Station Area	Housing Units	Percent
North Central Red Line	Mockingbird	803	14.6
	Lovers Lane	1727	31.5
	Park Lane	883	16.1
	Walnut Hill	166	3.0
	Forest Lane	705	12.8
	LBJ/Central	289	5.3
	Spring Valley	220	4.0
	Arapaho	622	11.3
	Galatyn Park	72	1.3
	Total	5487	100.0
Northeast Blue Line	White Rock	632	40.6
	LBJ/Skillman	402	25.8
	Forest/Jupiter	143	9.2
	Garland DT	381	24.5
	Total	1558	100.0
Southwest Red Line	Corinth	440	8.4
	Dallas Zoo	745	14.3
	Tyler/Vernon	1640	31.5
	Hampton	1785	34.2
	Westmoreland	604	11.6
	Total	5214	100.0
South Central Blue Line	Morrell	1184	20.1
	Illinois	1560	26.4
	Keist	1731	29.3
	VA Hospital	988	16.7
	Ledbetter	442	7.5
	Total	5905	100.0

Residential settlement patterns vary when considering the north and south regions. For the northern corridors, there are multiple station areas with sparse residential development. These areas are dominated by commercial and industrial land use. There may also be apartment buildings in some station areas but they are not represented in the study.

The southern corridors reside in regions predominantly of residential land use. The station areas are denser accompanied by a grid-like street system designed for residential development. The corridors in the south occupy a smaller area than the northern region. The northern rail lines expand further from the CBD of Dallas.

The following maps display the parcels, roads, and their stations in a regional context. Figure 2 and 3 express the geo-coded parcels as well as the street patterns of the station areas. The parcels are represented as shaded points set among the street patterns. Figure 4 illustrates the regional structure of the study area.

Figure 2. DART Stations for the Northern Corridors and their Geo-coded Parcels

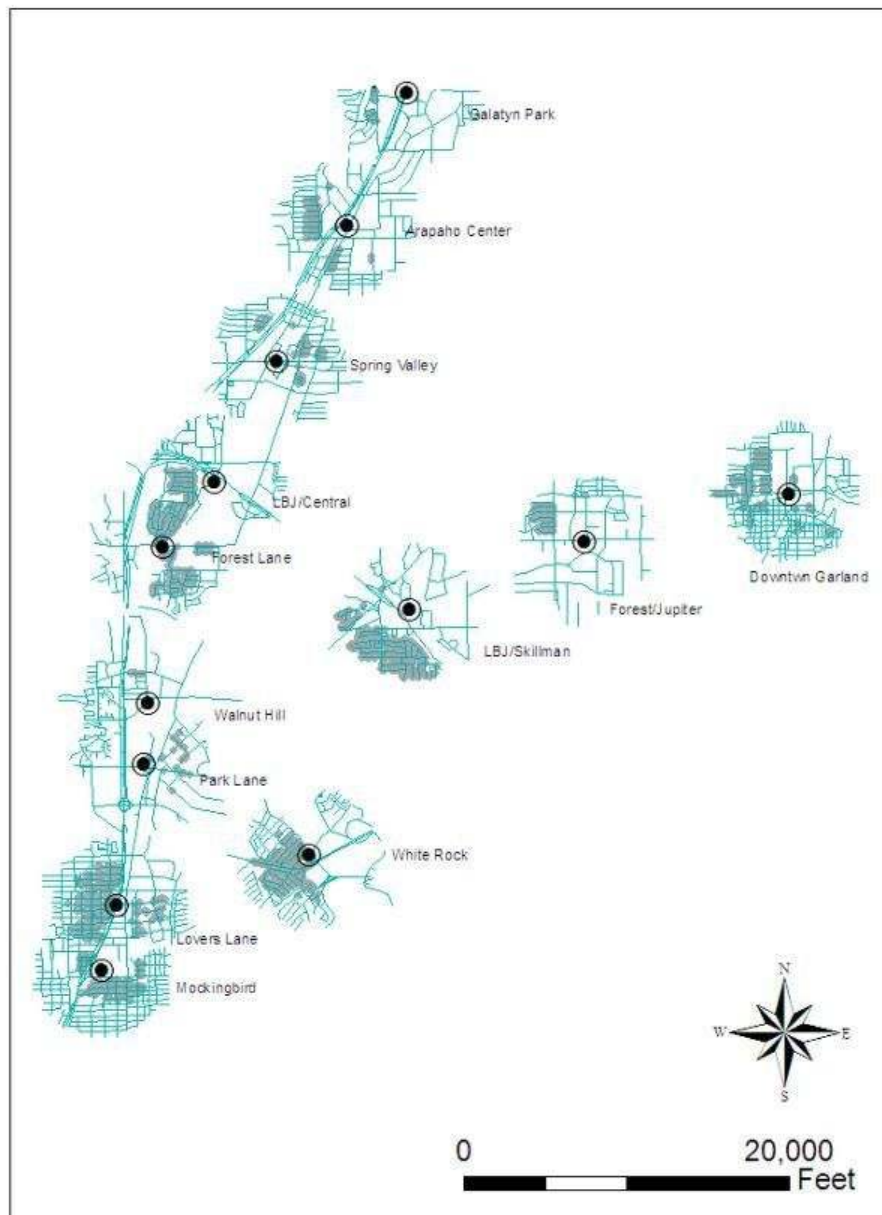


Figure 3. DART Stations for the Southern Corridors and their Geo-coded Parcels

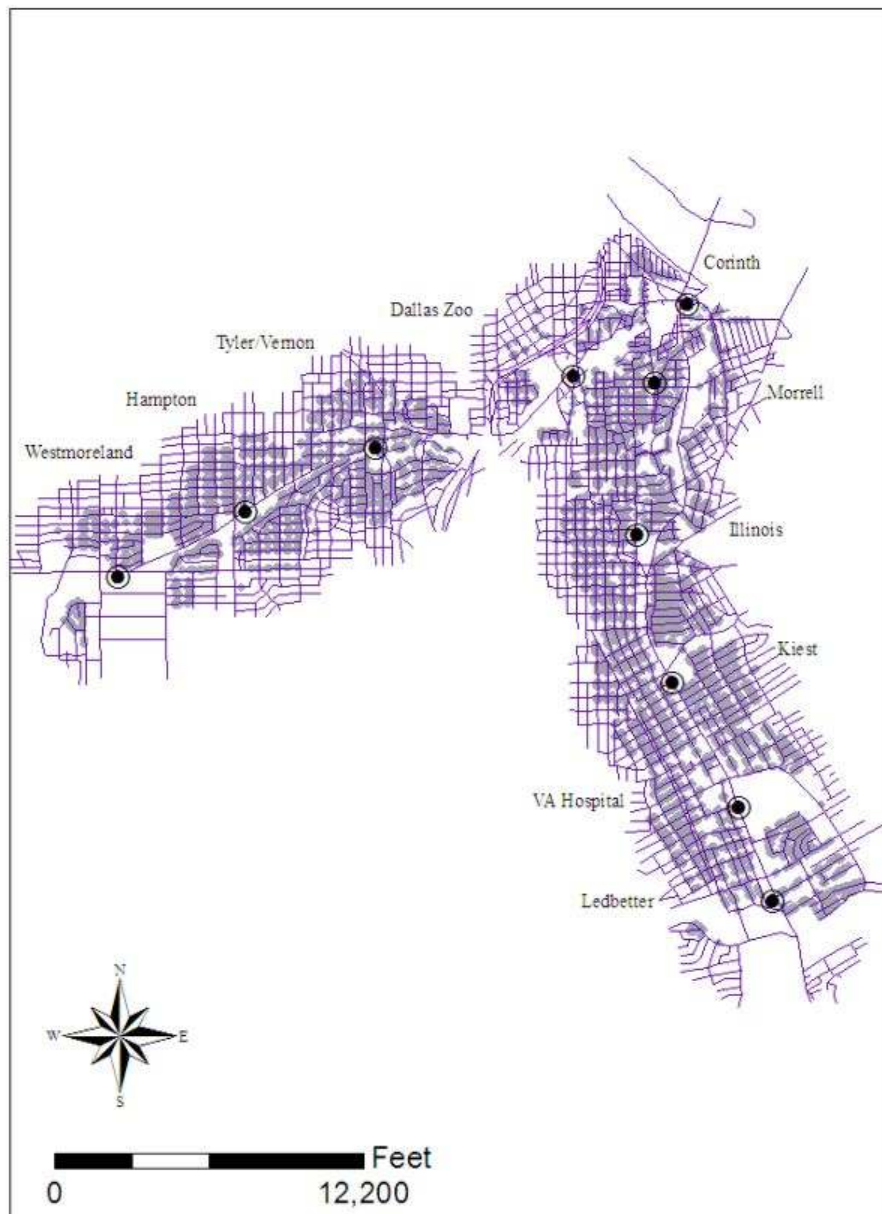
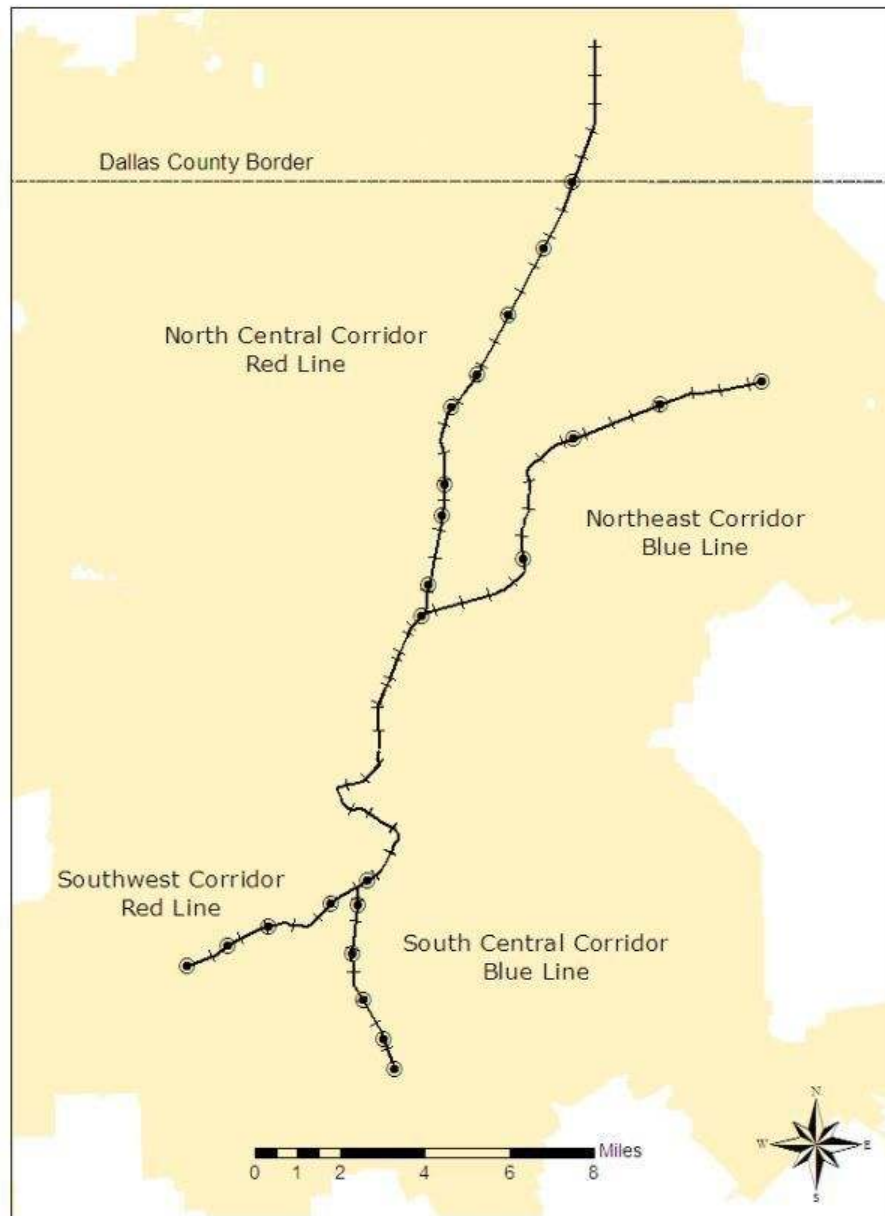


Figure 4. Development of Regional Taxonomy



Size and Value of Housing

Housing in Dallas County reveals regional differences in size and value as bounded by DART corridors. Figure 5 exhibits regional differences between the north and south lines. NE-Blue has the largest homes with an average living area of 1570 ft². The southern corridors have much smaller homes with SC-Blue a little under 1100 ft².

Figure 5. Average Living Area (ft²) by Corridor

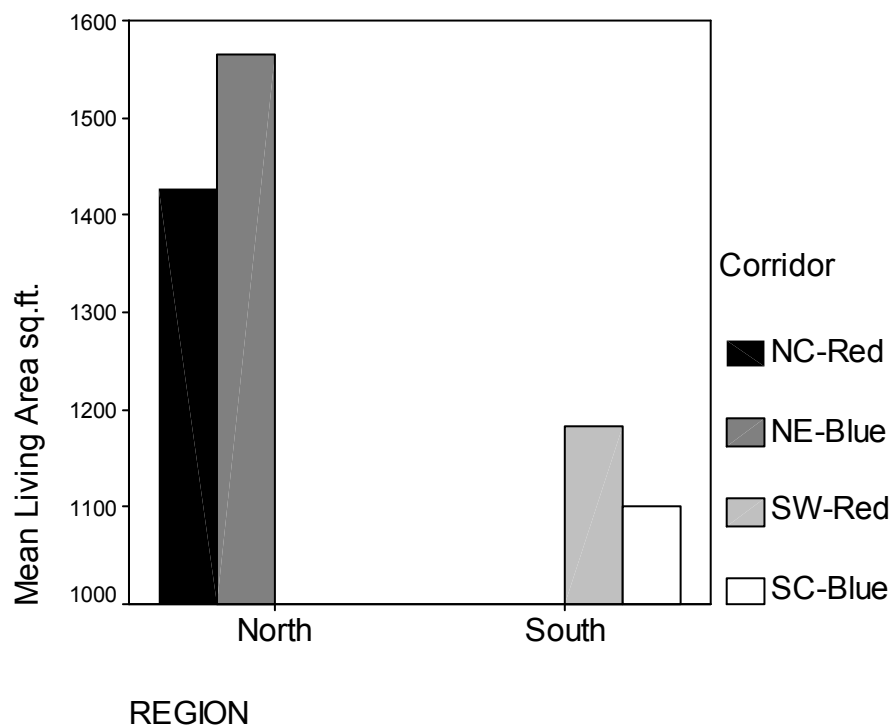
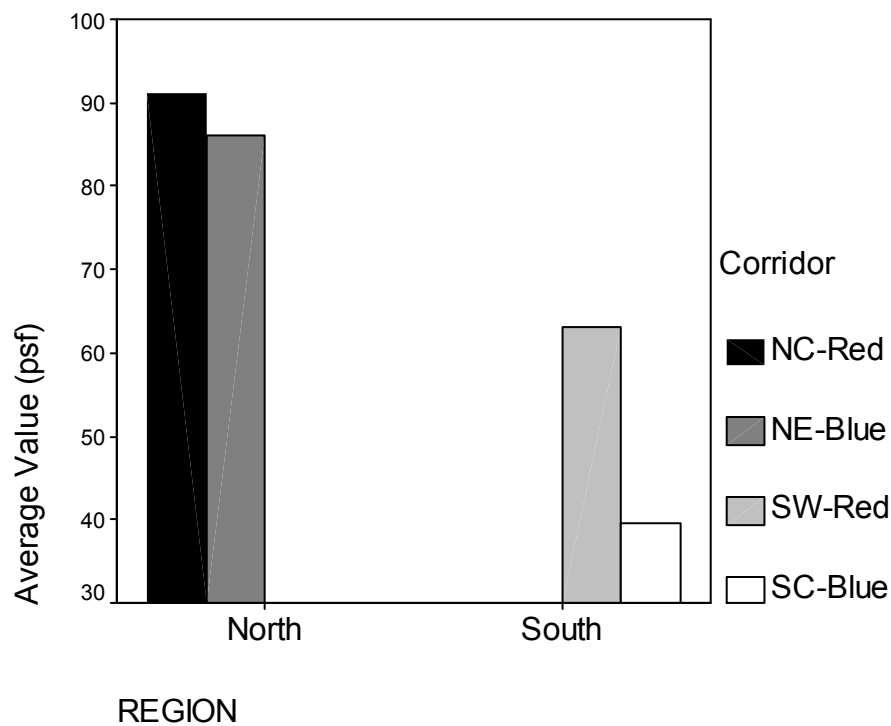


Figure 6 displays the value of these homes relative to size by comparing the housing value per ft². By observing the differences exhibited in the value per square foot of living area (\$/ft²), it communicates the relative value of area for each corridor. For the northern corridors, in terms of size alone, NE-Blue is the

largest, but when considering it on a $\$/\text{ft}^2$ basis, NC-Red has higher value but on average has less 'living area'. When comparing Figure 5 & 6 for the southern region, the disparity between SW-Red and SC-Blue increases for the $\$/\text{ft}^2$ analysis.

For the southern corridors, the average sized house for SW-Red is 7% larger than an average SC-Blue house. Yet, when considering $\$/\text{ft}^2$, the difference between SW-Red and SC-Blue increases by 57%. The value of living space in NC-Red is 2.2 times greater than the value of living space in SC-Blue.

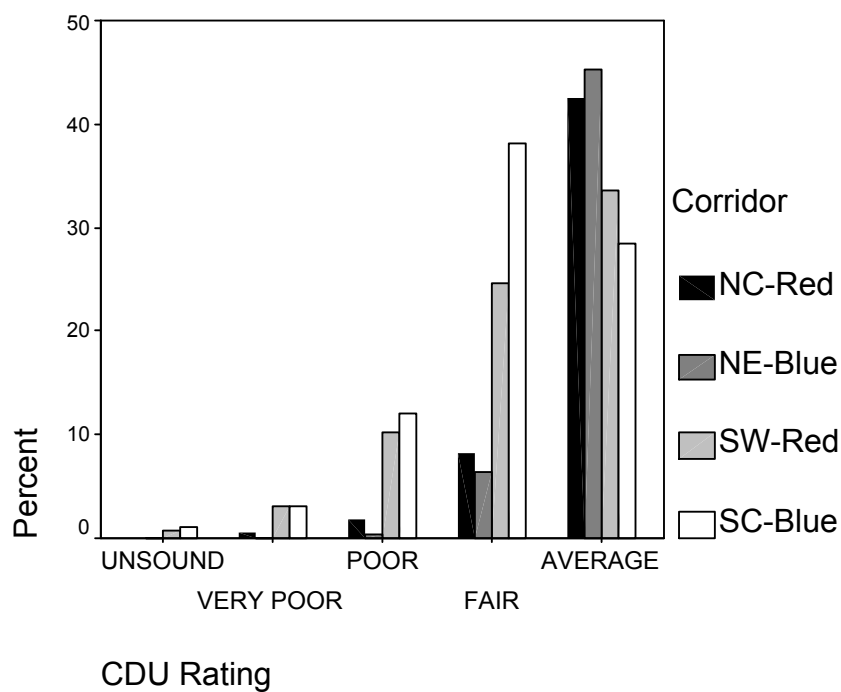
Figure 6: Average Value ($\$/\text{ft}^2$) by Corridor



CDU Ratings

One can further conclude that the composition of housing is regionally diverse by observing the distribution of CDU ratings. For each of the eight ratings, a detailed description is found in the appendix. They take into account the various types of construction material that makeup the structure. Figure 7 presents the distribution of the lower quality ratings ‘unsound’ through ‘average’ for each corridor.

Figure 7. Regional Distribution of Lower Quality CDU Ratings

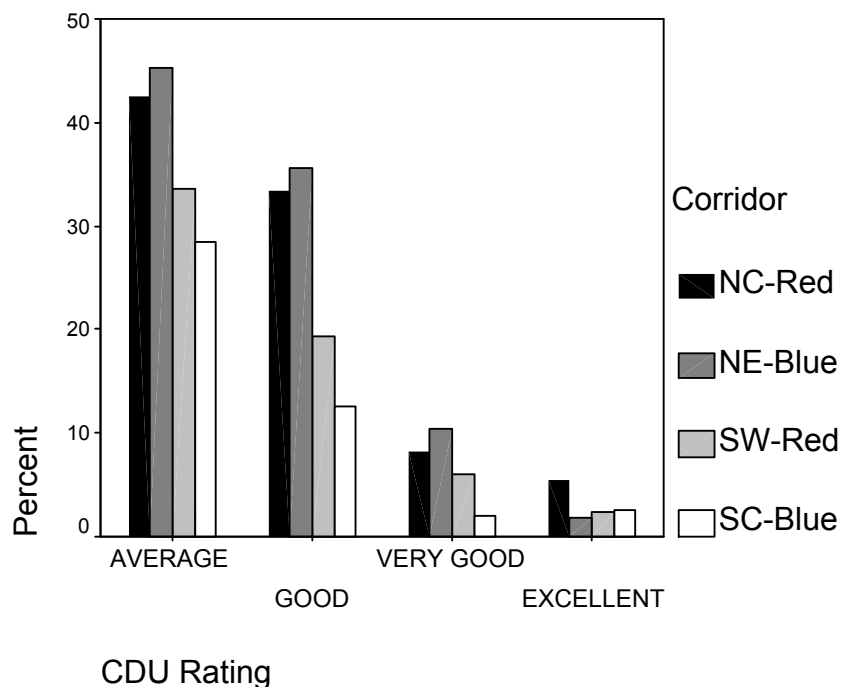


Higher percentages of housing with lower ratings of ‘unsound’, ‘very poor’, ‘poor’, and ‘fair’ are in SW-Red and SC-Blue while a higher proportion of ‘average’ ratings are located in the northern corridors.

The trend for higher quality housing located in the north is reinforced by the results in Figure 8. The southern corridors do not have higher proportions of ratings, 'average' through 'excellent'.

NC-Red and NE-Blue both share almost equal percentages of higher quality housing. SC-Blue has the smallest percentage of higher quality housing. Proportions of housing with the 'excellent' rating are dominated by NC-Red, while NE-Blue, SW-Red, and SC-Blue each share approximately the same percentage at 4%. The 'average' and 'good' CDU ratings are the most common designation assigned in the research.

Figure 8. Regional Distribution of Higher Quality CDU Ratings



Housing Type

The research distinguishes housing type as either a multi-family (MFR) or a single-family (SFR) residence. The multi-family housing variable consists of two sub groups identified as either a duplex or condominium. The merger of the two groups resulted in one common multi-family variable. The study does not include rental properties i.e. apartment buildings for MFR. Once segregated, the complete set consists of 14,564 SFR, 2,816 condominiums, and 793 duplexes creating a MFR variable amounting to 3,609 units.

Figure 9. Distribution of Housing Type

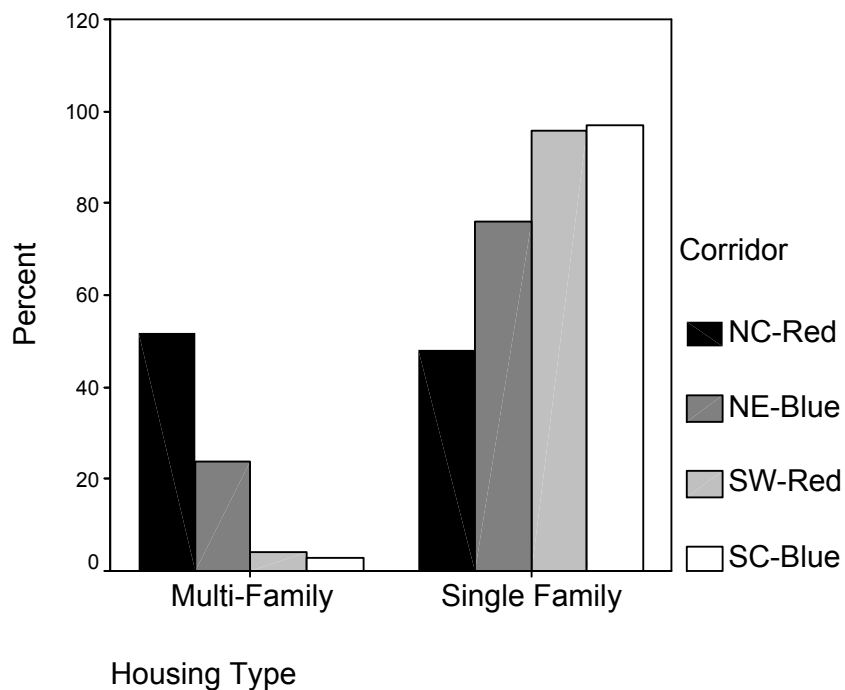
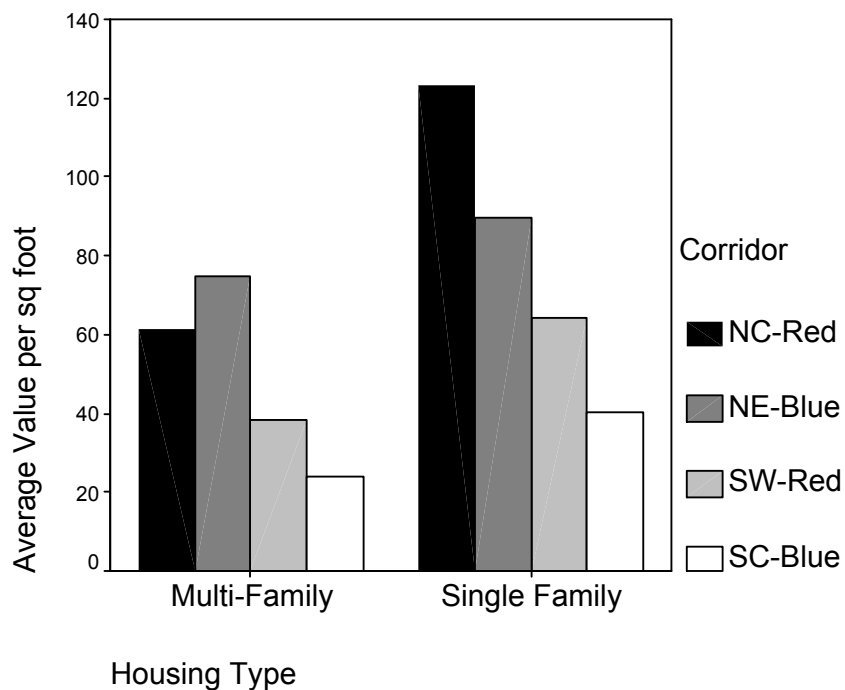


Figure 9 shows that NC-Red consists of approximately an equal amount of MFR and SFR. NC-Red clearly has the bulk of MFR in their corridor followed by

NE-Blue with approximately 20% MFR. The southern corridors, SW-Red and SC-Blue are comprised of mainly SFR with very little MFR.

Figure 10 shows the comparative value of living area for each corridor arranged by housing type. In terms of value per square foot (\$/ft²), NC-Red has the highest valued housing among their SFR. NC-Red also has the largest disparity between their MFR and SFR of nearly 100% with values of \$60 and \$120 per ft² respectively. For the category MFR, NE-Blue attains the highest value at \$75 per ft².

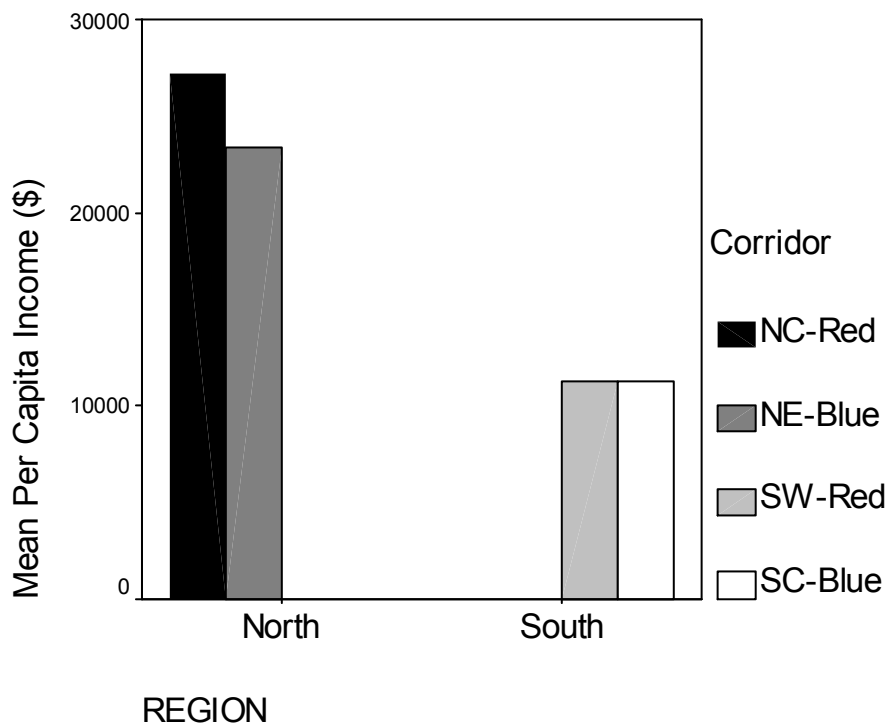
Figure 10. Value of Living Area (ft²) by Region



Average Per Capita Income (PCI) by Corridor

The northern regions on average outperform the southern corridors with larger and higher quality homes. An income analysis helps focus upon the demand for affordable transportation in low-income settings. Lower income neighborhoods may appreciate the transit station more due to reduced transport costs provided by transit (Nelson, 1992). Figure 11 presents income distributions by corridor.

Figure 11. Average PCI by Corridor



SW-Red and SC-Blue have almost identical average PCI values of \$11,306 and \$11,246 respectively. While the southern region as a whole has a consistent income distribution among station areas, there exist three particular station areas with unusually low-income levels. The station areas, Corinth,

Dallas Zoo, and Morrell with average PCI values of less than \$9500 depress the overall market value of the southern region. These well-populated station areas are located in a cluster at the junction of the southern red and blue lines (See Figure 4).

Relative to the southern corridors, the northern stations reside in better economic settings. Each station in the northern corridor outperforms the maximum average PCI station area in the south (Hampton station at \$12,186).

Summary

Each corridor has distinct characteristics in terms of size, value, type and income. The population of MFR is highest for NC-Red with it achieving an actual majority over their SFR. Larger housing predominates in NE-Blue, which is comprised of 80% SFR. In terms of the relative value of living area, SFR in NC-Red achieved the highest premium.

For the most part, the southern corridors possess higher densities in their residential development along with an established grid-like street system. Along with this density, the southern corridors have smaller homes that are valued less than the northern region. Furthermore, the residential settlements consist of mainly single-family detached housing. SC-Blue, with the densest development, consistently exhibits the corridor with the weakest housing market. SW-Red does not approach the depressed quality of SC-Blue but is still valued less than the northern corridors.

Income follows the trends of housing value when depicted in a regional context. The southern corridors clearly reside in lower income station areas when compared to the northern region. The cluster of stations, Corinth, Dallas Zoo, and Morrell accentuates the low-income status of the south.

CHAPTER IV

HEDONIC MODEL RESULTS

Development of Hypothesis

The hedonic model was applied to several conditions to quantify the influence that transit infrastructure has on property values. Consideration was given to the regional context, housing type, and income settings. Five hypotheses serve as a reference in formulating the results.

Hypothesis₁: Positive economic impacts result from proximity to a station.

Hypothesis₂: Negative economic impacts result from proximity to a rail line.

Hypothesis₃: Property value gradients vary regionally for the DART system.

Hypothesis₄: Multi-family property values appreciate the transit station more than single-family housing.

Hypothesis₅: Low income regions appreciate transit stations more than higher income regions as reflected in their property value gradients.

Proximity Model for Dallas County

The first analysis encompasses the entire study area in order to understand the overall response felt throughout Dallas County. Table 4 presents coefficients for the model components as outlined in the specifications for Equation 4. The hedonic model when applied to the complete dataset resulted in a weak yet significant relationship that proximity to the rail line and transit station

have upon property values. The amount of living area and the 'CDU Code' account for the strongest influence on property values with beta coefficients of 0.648 and 0.352 respectively. The number of bathrooms and the age of the structure have less influence on property value with responses comparable to that of proximity to the rail line and transit station.

Table 4: Proximity Model for Dallas County

	Beta	t	Sig.
(Constant)		-.928	.353
Living Area	.648	106.963	.000
CDU Code	.352	73.334	.000
# of Bathrooms	.034	5.135	.000
Age	.025	4.763	.000
Distance; Rail	.051	10.757	.000
Distance; Station	-.011	-2.250	.024

Rsq. = 0.696

N = 18,164

Predicted mean value; \$64,911

The hedonic model generates predicted values for each property following the trend of the regression from the hedonic model. If there was a perfect correlation in the model then the predicted value would be the same as the actual value. Having achieved an R^2 value of 0.696 for the complete dataset, the model does not capture the entire variation in property values. The predicted mean value of the dataset is not equal to the actual mean value. The predicted mean value for the complete set was \$64,913 with an associated beta of -0.011 for the 'Distant Station' variable. Literal interpretation follows that for every 1% of

distance (30 feet), the property appreciates 0.011% of the predicted mean value (\$7.14) to create a gradient with an economic benefit of \$7 / 30 feet. The rail line has a beta value of 0.051, thus translating into a nuisance effect of \$33 / 30 feet.

Multiple regression output provides information as to the proficiency of the model. For all models, R^2 , p -values, and t -values serve as indicators for the reliability of the model. R^2 expresses the proportion of variance in the dependent variable (property value) which can be predicted from the independent variables. In this case, 69.6% of the variance in property value is explained from the variables listed in the Proximity Model for Dallas County. The p -value found in the column labeled 'Sig', determines the significance of the coefficients. A statistical threshold of 0.05 or less would be statistically significant (i.e., you can reject the null hypothesis and say that the coefficient is significantly different from 0). In other words, for a coefficient to be statistically different from zero, it must attain a p -value less than 0.05. Larger betas are associated with the larger t -values, which in turn determine the level of magnitude of the variable. All model components in Table 4 achieve a p -value less than 0.05 making them statistically significant.

Regional Analysis

The Metroplex has vastly different housing characteristics, income distribution, and settlement patterns when considered in a geographical context. With regions as diverse as these, it is possible that property value gradients vary for the different corridors from the results generated for the complete dataset.

Regressions displayed according to their corridor assist in ascertaining effects on a local scale.

This research focuses upon the measured distance for the rail line and transit station. For presentation purposes, the remaining variables, 'Living Area', 'CDU Code', 'Bathrooms', and 'Age', though still incorporated in the model, no longer will be listed in the tables. Interpretations are only for the coefficients of the two proximity variables, the rail line and transit station. Table 5 presents results for the Proximity Model according to their respective corridors.

Table 5: Proximity Model Disaggregated by Corridor

Corridor		Beta	t	Sig.
NC - Red Rsq. = 0.776 N = 5487	(Constant)		-3.783	.000
	Distance; Rail	.059	7.375	.000
	Distance; Station	-.083	-10.541	.000
NE - Blue Rsq. = 0.809 N = 1558	(Constant)		20.451	.000
	Distance; Rail	.085	6.758	.000
	Distance; Station	-.058	-4.634	.000
SW - Red Rsq. = 0.703 N = 5214	(Constant)		16.131	.000
	Distance; Rail	-.044	-5.301	.000
	Distance; Station	.045	5.478	.000
SC - Blue Rsq. = 0.718 N = 5905	(Constant)		21.432	.000
	Distance; Rail	.214	26.354	.000
	Distance; Station	.041	4.981	.000

Results in Table 5 suggest that responses to the rail line and transit station vary regionally due to different environmental settings. The northern

corridors have expected responses to the transit infrastructure, i.e. negative and positive impacts for the rail line and transit station respectively. The intuitive response found for the northern corridors does not occur for the southern corridors. Instead, property values in SW-Red increase closer to the rail line and decrease for the transit station. Property values decrease the closer a property is to the rail line and transit station for SC-Blue. When disaggregated, the regional R^2 values improve upon the correlation for the complete set (greater than 0.696), thus explaining a higher proportion of variance.

Response to the Rail Line

In 3 out of 4 corridors, the rail line depreciates home values as postulated in hypothesis₂. The only corridor where the rail line serves as an amenity was SW-Red with a beta value of -0.044. SC-Blue rail line reacts strongest as a nuisance with a value of 0.214. Literal interpretation from the SC-Blue coefficient suggests that properties decrease in value 0.214% for each 1% increase in distance towards the rail line.

Response to the Transit Station

The transit station increases property values for NC-Red and NE-Blue with responses of -0.083 and -0.058 respectively. For the southern corridors, beta values reflect a decrease in property values for SW-Red and SC-Blue with values of 0.045 and 0.041 respectively.

An important relationship to consider is the net effect of the transit station and rail line response. The rail line diminishes the benefit of the transit station

when considering property value responses to the two features. The combined infrastructure response has a negative economic impact in all corridors except for NC-Red. The net effect for NC-Red responds with a positive impact carried by the station with a net coefficient of 0.024.

Explanation for the Nonconformity of the Southern Region

In reference to the lower incomes for the southern corridors, it was discovered that the three-station area (Corinth, Dallas Zoo, and Morrell) have disproportionately lower values when compared to other station areas in the region. These stations deserve further partitioning to control for possible adverse responses. The reasoning of the following control method is two-fold. First, it exposes the relative influence that property values have to transit stations in low income settings. Secondly, it is to discover the source of the contradictory results in the regional analysis for SW-Red and SC-Blue. The contradictory results being that the transit station was found to decrease property values for both corridors, while the rail line served as an economic benefit for SW-Red.

Table 6 displays regression results for the three-station area disaggregated by corridor. The Corinth and Dallas Zoo station areas are located in SW-Red while the Morrell station area resides in SC-Blue. The selections from SW-Red and SC-Blue have approximately the same number of properties at 1185 and 1184 respectively. The correlation coefficients for SW-Red and SC-Blue are also approximately the same at 0.821 and 0.783 respectively.

Table 6: Three-station Area Selection

Station	Measured Distance	Beta	t	Sig.
Corinth & Dallas Zoo (SW-Red) Rsq. = 0.821, N = 1185	.		.	.
	Rail Line	-.125	-8.850	.000
	Transit Station	.247	17.353	.000
Morrell (SC-Blue) Rsq. = 0.783, N = 1184	.		.	.
	Rail Line	.181	11.225	.000
	Transit Station	.211	12.971	.000

The significant and strong response to the rail line and transit station is consistent with the regional results yet of much greater magnitude. For the Corinth and Dallas Zoo station areas in SW-Red, property values increase closer to the rail line at three times the rate of the regional results. For the transit station, property values decrease nearly six times the rate of the regional response of SW-Red (see Table 5 for regional results). This isolated area may be the source of the contradictory results in the regional model. When comparing Morrell to the regional model, the negative response intensifies for the station, increasing from 0.041 to 0.211.

The unusually high responses for the three-station area reveal the contradictory nature of the regional results for the southern corridors. When reprocessing the model for the southern corridors controlling for the three-station area, results in Table 7 are similar to the trends of the northern corridors.

Table 7: Regional Analysis Controlling for the Three-Station Area

Corridor	Distance	Beta	t	Sig.
NC-Red	Rail Line	.059	7.375	.000
	Transit Station	-.083	-10.541	.000
NE-Blue	Rail Line	.085	6.758	.000
	Transit Station	-.058	-4.634	.000
SW-Red	Rail Line	.042	4.418	.000
	Transit Station	-.039	-4.175	.000
SC-Blue	Rail Line	.217	24.864	.000
	Transit Station	-.086	-9.629	.000

Corridor	Mean (\$)	R - Squared	N
NC - Red	92,624	.776	5487
NE - Blue	122,100	.809	1558
SW - Red	79,513	.702	4029
SC - Blue	42,385	.722	4721

A positive benefit for the transit station and a negative impact for the rail line consistently occur throughout the corridors. SC-Blue now has the strongest response for both the rail line and transit station. The northern corridors remain unchanged but NC-Red is still the only corridor that achieves a net benefit from the combined infrastructure.

Regional Analysis by Housing Type

Why is NC-Red the only corridor to have a net positive impact from the rail line and transit station? Does the high proportion of MFR contribute to the net economic benefit?

Disaggregating both housing type and region permits a comparison of expressed implicit values for MFR and SFR. There are only 260 MFR units in the southern corridors compared to 3217 MFR units for the northern region.

Table 8; Housing Type Controlling for the Three-station Area

Corridor	Type		Beta	t	Sig.
NC-Red	MFR	Distance; Rail	.118	6.788	.000
		Distance; Station	-.192	-11.120	.000
	SFR	Distance; Rail	.075	6.320	.000
		Distance; Station	-.075	-6.294	.000
NE-Blue	MFR	Distance; Rail	.060	3.112	.002
		Distance; Station	-.162	-8.176	.000
	SFR	Distance; Rail	-.033	-2.451	.014
		Distance; Station	-.054	-4.209	.000
SW-Red	MFR	Distance; Rail	.083	.936	.351
		Distance; Station	-.063	-.656	.513
	SFR	Distance; Rail	.049	5.205	.000
		Distance; Station	-.056	-6.023	.000
SC-Blue	MFR	Distance; Rail	.376	7.308	.000
		Distance; Station	-.077	-2.573	.011
	SFR	Distance; Rail	.101	11.290	.000
		Distance; Station	-.058	-6.423	.000

Corridor	Type	Predicted Mean (\$)	Rsqr. Value	N
NC-Red	MFR	52,365	.642	2843
	SFR	171,000	.723	2644
NE-Blue	MFR	108,650	.899	374
	SFR	126,690	.845	1184
SW-Red	MFR	57,308	.615	113
	SFR	80,626	.713	3916
SC-Blue	MFR	22,802	.910	147
	SFR	43,238	.730	4574

The housing type model, for the most part, exhibited responses similar to the trends of the regional model with the transit station being a benefit and the rail line a detriment to property values.

When considering property values and transit stations for each corridor, MFR property values increased at faster rates than SFR except in SW-Red where results proved insignificant. The prominent coefficients for MFR expressed beta values of -0.192 and -0.162 for NC-Red and NE-Blue respectively. SFR beta values for NC-Red and NE-Blue were -0.075 and -0.054 respectively. NC-Red is the corridor that has the highest proportion of MFR at 52% with 2843 properties. With a slight majority, MFR contributes to the regional benefit that transit stations provide to property values. There is a large disparity between the predicted mean values of MFR and SFR. MFR property values may increase at a faster rate but have a modest predicted mean value of \$52,365 when compared to SFR in NC-Red with a higher value at \$171,000.

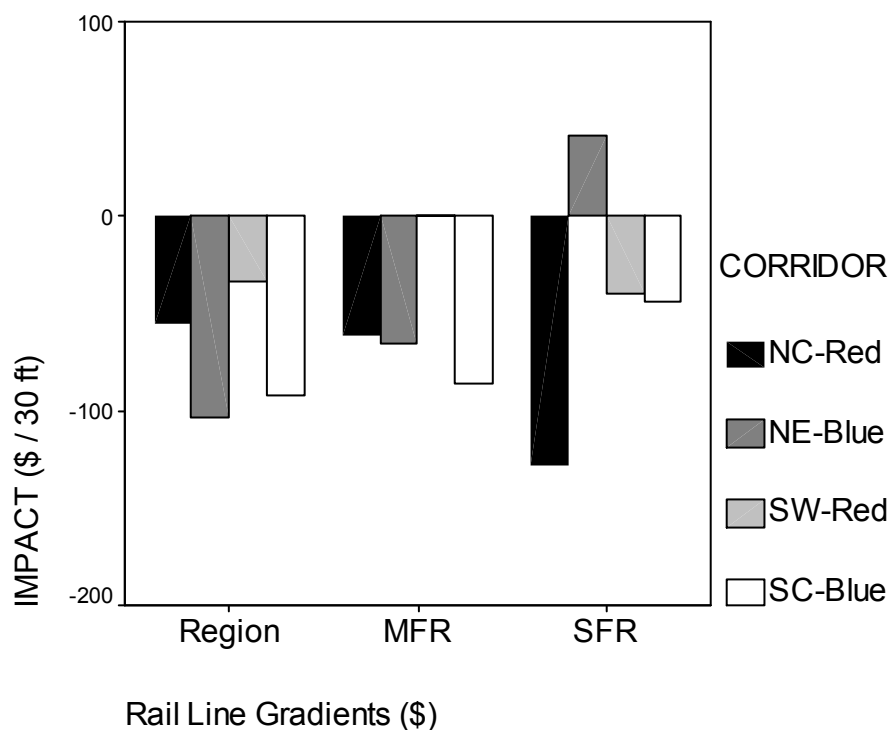
Property values decreased closer to the rail line in all corridors except for NE-Blue where the SFR reacted positively with a beta of -0.033. MFR property values had stronger negative responses than their respective SFR for each corridor. The largest beta value (0.376) occurred for MFR in SC-Blue.

Coefficients Quantified in Dollar Terms

Each property value gradient was calculated by considering the beta as a percentage of its predicted mean value. The property value gradients, when quantified in monetary terms, are directly proportional to their respective

predicted mean value. Figures 12 and 13 express the quantified gradients for the rail line and transit station respectively. Calculations for the regional corridors, MFR, and SFR are represented in the two graphs. The regional results reference the model that controlled for the three-station area.

Figure 12. Dollar Valuations for Property Value Impacts and the Rail Line

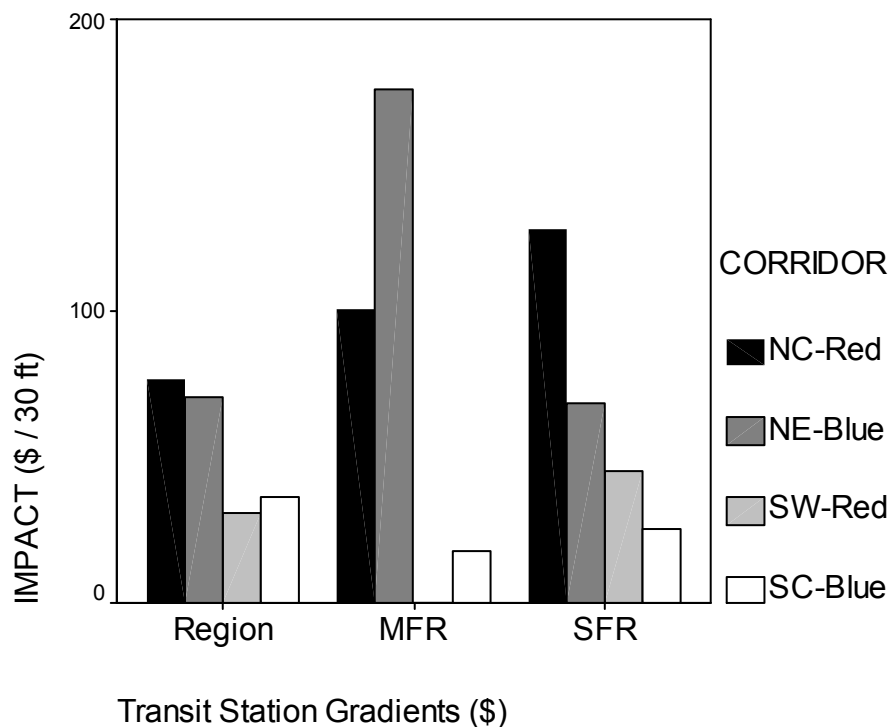


Economic Impact from the Rail Line

There is a consistent negative impact for all instances except for the SFR in NE-Blue. For the region, NE-Blue and SC-Blue suffer the greatest loss in property values from the rail line with gradients of \$104 and \$92 per 30 feet respectively. As for housing type, SFR had the greatest negative impact occurring in NC-Red with a gradient of \$128 per 30 feet. MFR property values decreased \$62 and \$65 per 30 feet for NC-Red and NE-Blue respectively

Figure 13 expresses the positive economic impact that results from proximity to a transit station. The results indicate the consistent positive relationship that transit stations have upon property values.

Figure 13. Dollar Valuations for Property Value Impacts and the Transit Station



Economic Impact from the Transit Station

Property values in each corridor appreciate the proximity to transit stations. For the region, NC-Red and NE-Blue both had similar responses to the station with values of \$77 and \$71 per 30 feet respectively. SW-Red and SC-Blue received benefits of \$31 and \$36 per 30 feet respectively. The lower valued housing in SC-Blue actually produced greater benefits than SW-Red once controlling for the three-station area.

NC-Red with nearly an equal proportion of MFR and SFR observed greater impacts from its SFR. MFR and SFR in NC-Red had gradients of \$101 and \$128 per 30 feet respectively. For NE-Blue, MFR impacts were greater than its SFR with values of \$176 and \$68 respectively.

Regional Benefits

Focusing on the regional gradients assist in understanding the net effect on property values felt by the proximity to the rail line and transit station. When calculating the net value for each regional response, NC-Red remains the sole corridor to gain an economic benefit from the combined infrastructure. The net sum of the two gradients of NC-Red leaves a positive impact of \$22 per 30 feet. SC-Blue experienced the greatest loss from its combined infrastructure with a negative impact at \$56 per 30 feet.

Discussion

Hypothesis₁

Positive economic impacts result from proximity to a transit station.

Affordable access and less dependence on the automobile provide property owners an advantage living close to transit stations (Alonso, 1964; Muth, 1969). When considering the entire study area, property values react positively to the transit station. The magnitude of the reaction was weak yet statistically significant as demonstrated in the results for the complete dataset. Property values increased towards the transit station in each corridor once controlling for the three-station area.

Hypothesis₂

Negative economic impacts result from proximity to a rail line.

The complete dataset demonstrated that property values decrease from the rail line due to the negative environmental settings. Noise, vibrations, and poor aesthetics may create inhospitable areas for residential development (Strand and Vagnes (2001). This relationship was reinforced for the regional results as well.

Hypothesis₃

Property value gradients vary regionally throughout the DART LRT system.

When considering the geographical distinctness of residential development in Dallas County it merited regional analysis. Formation of the regional taxonomy followed the transit corridors partitioned by the north and south regions. Subsequent descriptive statistics emphasized the regional disparity in housing value, type, and income distribution. It was found that property values increased closer to the transit station for the northern corridors but properties in the south reacted differently. Property value responses in the southern regions differed from the north for the rail line and transit station. There was even a sub region in the south that influenced the general response of the southern corridors.

Hypothesis₄

When considering the transit station, property values increase at a higher rate for multi-family housing more so than for single family housing.

Multi-family housing, located predominantly in the northern corridors, appreciated higher premiums closer to transit stations as reflected in the housing type models. Multi-Family housing achieved beta values nearly three times greater than the single-family results. Past research indicated that multi-family housing responds stronger to transit stations (Cervero and Duncan, 2002). Multi-family housing may consist of a demographic that finds affordable access a valued utility while single detached housing is more oriented around the automobile.

Hypothesis₅

Low income regions appreciate transit stations more than higher income regions as expressed in their property gradients.

The southern region clearly has lower incomes than the north. The income distribution for the southern corridor is not consistent throughout. There were three stations located at the red and blue line junction with characteristics of extreme poverty. When controlling for the depressed three-station area, it was found that the station did increase property values in the southern corridors.

When disregarding the three-station area, the regional results alter for the southern corridors. The corridor with the lowest income setting achieved the greatest appreciation of property values for their transit stations. SC-Blue, a source of depressed property values, had the highest appreciation rates in all four corridors.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

Research Findings

The central question of this paper asked if there are positive externalities resulting from transit infrastructure which can mediate the tax subsidy of DART LRT. Residents may value the transit station as a source of affordable access while the rail line could possess negative qualities. The value of access for this study was defined by the change in property value relative to the measured distance from the rail line and transit station. The magnitude of property value gradients improved when the study area focused upon corridors instead of the Dallas County. When disaggregating the data by region, gradients strengthen along with their predictive powers. It became possible to isolate the unique factors that contribute to a region's response whether negative or positive. For instance, it was discovered that MFR contributed to the positive impact of the transit station for the northern corridors. In contrast, there was a sub region in the south that reacted to the station unfavorably, influencing the overall results for the two southern corridors.

The station presents itself as a feature that enhances property values but its accompanied rail line depreciates home values. The rail line, with its undesirable elements, poses as a detriment to property values consistently

throughout the DART system. This research was consistent with the results obtained by Landis (1994) and the BART system. Alameda (\$2.29/meter) and Contra Costa (\$1.96/meter) counties both received the stations as an amenity with modest gradients. For Dallas County, the gradients were weaker when compared to the BART study. DART when considering the entire county, obtained a gradient of \$0.71 / meter after converting to the units used for the BART counties. However, when focusing on regional output, the gradients were comparable to the BART results.

Implications

There is no doubt that the costs of traffic congestion will continue to rise. One possible solution to the growing problem of auto dependency is through the implementation of light rail transit. This particular mode of transportation suffers from its inability to become fiscally viable. For DART, the local taxpayers carry the burden of its fiscal shortfalls. Any external economic benefit caused by the light rail system is welcome to DART cities. The convenience of light rail is relative to the functionality of auto travel. As the costs of traffic congestion and auto operating expenses increase, the public perception of LRT improves.

With a direct cost to the taxpayer, policy makers of Dallas County strive to portray LRT as a mechanism to improve urban lifestyles. In economic terms, LRT is not able to support itself without subsidies. Residents find it easier to vote for this service due to the shared costs. Dispersal of costs diminishes the fiscal

liability. With tentative public acceptance, it leaves transit with the responsibility to demonstrate external benefits.

Not every resident receives the benefits of a transit project equally. There are select stakeholders who benefit more from a LRT system. Elected officials, environmentalists, engineering firms, developers, and regional businesses all are stronger proponents of transit. These stakeholders enjoy a direct form of economic benefit but do not necessarily live close to or utilize LRT. It would be possible to extend this list of beneficiaries to property owners if indeed property values increased closer to transit stations. If in fact property owners chose to locate near transit stations to take advantage of the affordable access, the demand of this amenity would be reflected in the value of their homes.

Elevated property values are only one external benefit to consider in transit's capacity for economic development. General TOD principles contribute to economic growth such as its ability to promote job growth and enhance pedestrian environments. Transit has the ability to attract retail and improve the livability of these areas, but these amenities often are difficult to quantify. Property value analysis serves as a quantifiable technique employed by researchers to assess the community's reaction to transit infrastructure and give meaning to the intangibles. However, if property values of surrounding residences react negatively, the opportunity to capitalize on the service remains unfulfilled and development needs alternate strategies. If it can be determined that positive value gradients exist around transit stations with diverse, dense

residential patterns, this can serve as a criterion in promoting residential TOD with select retail. Areas with higher negative reactions to rail deserve improvements by offering more service-friendly retail and less homogenous single-family housing. Extreme negative reactions to the transit station raise awareness to surrounding external factors that need remediation to better market the utility in the area.

When considering the work of Alonso (1964), it suggests that proximity to transit infrastructure increases property value due to reduced transport costs. A transportation system has the opportunity to provide access to employment and social services. The importance of understanding the economic impact of light rail is a quality of life issue. Planners and public transit advocates recognize the opportunity transit provides to economically disadvantaged areas. In order for public expenditures to be invested wisely, these isolated segments of society should be incorporated into the network by implementing affordable housing in areas that provide LRT access.

If there were insignificant results for property gradients near transit stations, then the option to walk to transit may not be appreciated due to the high degree of 'convenience' that the auto offers. With established, ubiquitous highway access, the influence of light rail is negligible. Only when urban densities reach levels of countries like Japan, where auto travel is not feasible, does transit stations affect land value. Cities, such as Tokyo, consider the placement of transit stations a vital factor in real estate development decisions

(Clower, 2002). Commuters orientate their lifestyles around the transit infrastructure without the option of auto travel. In contrast, a city such as Dallas, Texas is acculturated into an auto-oriented environment. Until urban densities and traffic congestion reach critical levels, transit stations will have a minor affect on land value while public funds continue to be directed towards highway improvements (Armstrong, 1994).

To better capitalize on the city's investment in DART, the complexities of residential value capture must be realized through better land use decisions in transit station areas. What are the policy implications if it can be demonstrated that a certain composition of housing reacts positively to stations? If these areas do exist, there are opportunities to implement guidelines to promote TOD housing. If higher valued housing responds negatively to a transit station, it provides the option of developing pedestrian retail in order to convey the potential of transit.

Limitations

There needs to be a comprehensive approach in formulating comparisons of property value impacts. Numerous studies conducted on the subject all have different procedures in generating results making comparisons difficult. For example, the process of measuring proximity is not consistent. Some researchers measure Euclidean distance while others use the street network. Other inconsistencies exist such as the units of measurement between meters and feet or usage of terms such as 'near' and 'adjacent'. The price of homes can

be in absolute terms or per unit of space. The models also can generate increases in direct dollar terms or through logarithmic elasticity.

Many features influence property values in urban environments. It cannot be certain if transit infrastructure is the absolute cause of property value gradients. Neighborhood evolution may be completely independent from the presence of transit. There may be negative influences introduced to the study area before the implementation of DART that hinder economic potential, i.e. industrial uses or criminal elements. Choices for the homebuyers may be influenced more for the quality of schools than for affordable transportation.

Researchers acknowledge numerous sources of error in their results. When considering the variable of distance in the model, it is an imperfect measurement. Noise, as an environmental effect, has various factors presented to it that may cause inconsistent results. For example, topography and elevation play a factor in how a residence receives noise levels. A multi-family unit possibly could be located on upper levels facing away from the railroad. Some residences may have structures blocking the view of the tracks while others are more exposed. Trees and manmade barriers could protect single-family residences. Issues as these may render the results biased and contribute to the difficulty for comparisons among LRT systems.

Recommendations

Many available opportunities exist to improve upon the current study. The gradients represented in this study were instantaneous in time. With DART

being approximately a decade old, a time-series analysis would be helpful to see how the gradients respond temporally.

The processed data on home values originated from a public assessment of the property. Many researchers prefer the use of actual sales data to improve upon the definition of market value. Assessed property values are open to protest. Homeowners who feel their assessed value was arrived at unfairly have the opportunity for review before a council, thus contributing to the inconsistency of the dataset.

Common strategies applied to real estate impact studies measure the effect proximity has on commercial property. Office rents act as a dependent variable, regressed upon proximity and other environmental factors. Cervero & Duncan (2001) incorporated the number of jobs available in the station area along with median incomes gained from employment in the station area. The substitution of apartment rents is possible where there is little homeownership.

It would also be helpful to add a qualitative element to the research. To account for design elements in the station areas could assist in supporting quantitative results. Perhaps negative responses to station areas were the result of excessive parking at the core of the station area. Consideration to the type of current land use within the station area deserves examination along with the development priorities of the municipality. Does the current retail use cater to the automobile or the pedestrian? What are the socio-economic conditions of the

station area? To develop questionnaires or surveys may assist in understanding the preference residents place upon the transit service.

To explain other influences on property values, common features such as schools and parks may be compared to the gradients of transit stations. In understanding the influence of automobile access, the highway interchanges deserve attention. As developed in the Landis study (1994), value of access for the automobile merits comparison to transit access. Further comparison to the type of rail system may provide insight to the advantages of LRT. LRT utilizes less noisy and smaller rail cars than commuter trains or freight cars. It becomes possible to locate rail lines primarily served by freight vehicles and test for increased nuisance responses. Lastly, DART has a number of stations planned for operation in the near future. A comparison of those stations that are proposed for implementation to the ones in current operation may yield significant results.

APPENDIX

CDU DEFINITION

General Descriptions - Various Quality Classes

Users should keep in mind that the descriptions provided are typical of improvements within each class. They do not represent minimum standards and should not be used as the sole determinant for assigned quality class.

Very Poor Quality

General Description

Minimum shelter. Small box or single-wall structure of inferior materials, poor design, and poor workmanship. Not attractive in appearance.

Typical Features

Few electrical outlets, one bath, stove heaters, no garage or porch, one outside door, 400 to 500 square feet of living area.

Poor Quality

General Description

Inexpensive structure. Small masonry, veneered box, or wood frame structure of inexpensive materials, poor design, and poor workmanship. Not attractive in appearance.

Typical Features

Few electrical outlets, cheap fixtures, one bath, stove heaters, no garage or carport, small porch, 400 to 800 square feet of living area.

Fair Quality

General Description

Low cost structure that meets minimum building code requirements. Usually built from stock plans. Small to medium masonry, masonry-veneer, or wood frame structure of fair materials, design, and workmanship.

Typical Features

Adequate electric outlets, standard builders' fixtures, one bath, 1-car garage or carport, small front and rear porches, stove or wall heaters, window unit air conditioners, 800 to 1,200 square feet of living area.

Average Quality

General Description

Average house of average design, materials, and workmanship. Houses of this type are usually of two to four floorplans within a subdivision.

Typical Features

Ample electric outlets, average fixtures, fireplace (optional), 1 ½ - 2 baths, 1 or 2-car garage or carport, front and rear porches or patios, L shape or other variation from rectangle, central heating and cooling, 1,000 to 1,800 square feet of living area.

Good Quality

General Description

Good structure of above-average materials, design, and workmanship. Attractive in appearance.

Typical Features

More than ample electric outlets, custom fixtures, 2 - 2 ½ baths, 2-car garage or carport, large porches or patios, L, U, or I shape, sliding glass doors, central heating and cooling, fireplace, 1,600 to 2,000 square feet of living area.

Very Good Quality

General Description

Very good structure of desirable materials, design, and workmanship. Custom built from good architectural plans by a good contractor. Attractive in appearance.

Typical Features

More than ample electric outlets, custom fixtures, 2 - 3 baths, 2 or 3-car garage, large porches or patios, -irregular shape, sliding glass doors, central heating and cooling, fireplaces, 2,000 to 3,000 square feet of living area.

Excellent Quality

General Description

High-quality structure of excellent materials, design, and workmanship. Custom built from good architectural plans by a good contractor. Attractive in appearance.

Typical Features

Numerous electric outlets, custom fixtures, 3 - 4 baths, 3 or 4-car garage, large porches or patios, irregular shape, sliding glass doors, central heating and cooling, fireplace, 3,000+ square feet of living area. Also, special features such as balconies, skylights, saunas, and atriums.

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